

Clinical Observations on the Remineralization of Stage 1 Enamel Caries Lesions Using a Tray-Based Protocol: A Case Report

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Abstract

Aim: To demonstrate that stage 1 caries lesions in a moderate-to-high-risk young adult can be successfully remineralized with a customized protocol

Background: While some clinicians respond immediately to demineralized enamel with surgical procedures (e.g. sealants, microabrasion, restorations), holistic or minimally invasive approaches preserve tooth structure while achieving remineralization of such lesions.

Case description: We report on the application of a tray-based protocol that prolongs contact between a multi-mineral NaF dentifrice and the teeth of a young adult manifesting stage 1 caries lesions.

Conclusion: Instead of invoking procedures that generate tissue loss (no matter how minimal), reversible conditions of a moderate-to-high-risk patient demonstrating stage 1 caries can be addressed via creative, minimally invasive approaches, such as delivery of a multi-mineral dentifrice via mouth trays.

Clinical significance: The minimal interventional approach we used required patience and creativity, and produced remineralization of incipient caries lesions in a moderate-to-high-risk patient. Importantly, this case study also demonstrates the importance of understanding the psychology of the patient, acquiring a detailed history of habits, and devising a customized, preventive-focused protocol to match the patient's needs.

Introduction

Dental caries is a disease afflicting mankind since time immemorial [1]. Considered a lifestyle disease, dental caries is not only caused by an excessive intake of sugar-rich foodstuffs but also is related to the environment of the oral cavity, including the number and type of bacteria, salivary flow and buffer capacity, frequency of dietary exposures, age, medical treatments, psychology, dental knowledge, and oral hygiene habits [2]. Despite much research in the field of clinical and preventive dentistry, dental caries continues, unabatedly, challenging us to think of creative methods to prevent, manage and treat it.

Fluoride remains a clinically effective agent in preventive dentistry but its efficacy can be limited in certain clinical scenarios, leading to frustration of both the patient and the clinicians [2]. One method of improving fluoride's effect may be through supplementation with calcium phosphate materials. Other techniques include devising formulations, such as fluoride varnishes, that extend the contact time of fluoride with the tooth surface and while some clinicians respond immediately to demineralized enamel with surgical procedures (e.g. sealants, microabrasion, and restorations), which may increase the risk of future complications (e.g. secondary caries), holistic or minimally invasive approaches can preserve tooth structure while achieving long-lasting remineralization.

In this Case Report, we report on a novel method of prolonging the duration of a multi-mineral dentifrice on the tooth surface. This method is designed to remineralize stage 1 caries lesions while also improving periodontal health, and is therefore intended for moderate-to-high-risk caries individuals.

Case Report

A 16-year-old boy was brought to the dental office for a routine check-up by his parents. Upon inspection, his maxillary anteriors showed breaks in enamel and loss of tooth structure on the labial surface (Figure 1). The dental caries lesions (as indicated with black arrows) were excavated and the four teeth manifesting irreversible damage were restored with Ketac[®] N100, a resin glass ionomer having good esthetics and the ability to attain a high polish. Despite instructions and requests, the patient however never came back for a follow-up appointment.

Four years later, the patient returned for a routine prophylaxis. All four restorations appeared clinically sound (maxillary anteriors in Figure 2), plaque control was reinforced and a basic prophylaxis was performed. Noticeably, the mandibular anteriors showed white chalky demineralized enamel on the labial surface (mandibular anteriors in Figure 2). The demineralization had not yet progressed to dentin and as such we recommended topical fluoride application to help remineralize the affected enamel.

Fluoride varnish (3M Clinpro[®] White Varnish with 5% NaF plus TCP) was applied as per the manufacturer's instructions on day one to the maxillary and mandibular teeth (Figure 3). Patient was instructed to brush lightly on the teeth, as vigorous brushing could remove the soft white chalky enamel. He was asked to return to the dental clinic every week for an assessment of his oral hygiene and to monitor the status of the white chalky lesion. Unlike the experience four years ago, the patient returned each week as instructed.

After a month, however, there was no improvement in the lesions on

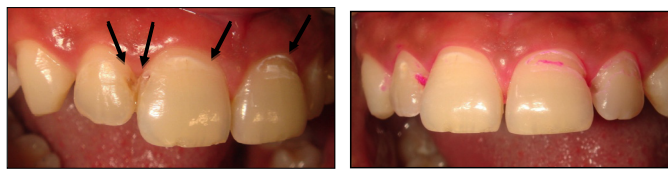


Figure 1: Baseline photos of the 16-year-old patient's upper anterior teeth demonstrating presence of enamel breaks and/or loss of tooth structure. Photo on left is off-center to demonstrate location of the four restorations (denoted with black arrows). Breaks in the enamel are further resolved with the caries detector purple dye, as shown in the right-hand photo. All four teeth were restored with a Resin Modified glass-ionomer.



Figure 2: Panoramic and close-up views of the upper and lower anterior teeth four years later (patient was 20 years old). The four restorations were in sound condition, but the lower anteriors manifested stage 1 caries lesions accompanied with irritated gingival tissue.



Figure 3: View of the anteriors after a fluoride varnish treatment.

the mandibular anteriors (Figure 4). In attempting to identify factors contributing to the resistance of remineralization, it was realized that the patient's personal habits history had not been recorded; when asked about his habits, he reported that he was a smoker.

Treatment

Given the prevalence of demineralization on the mandibular anteriors, an opportunity presented to devise a protocol that increased the level of preventive therapy as discussed below.

Alginate impressions of the maxillary and mandibular arches were taken, and using the vacuum former, silicon trays were prepared. These trays were used as carriers for the Clinpro® Tooth Crème. A pea-sized amount of Tooth Crème was dispensed and spread in each tray and then positioned on the teeth (Figure 5). The patient was instructed to brush his teeth after dinner and then wear the tray for 15 minutes while maintaining reasonable pressure to ensure the dentifrice contacted the tooth surfaces. If any dentifrice managed to spill over into his mouth from the tray, he was instructed to spit it out. After 15 minutes he was asked to remove the tray, expectorate any residual paste and not to rinse his mouth. The patient was supplied a tube of Clinpro® Tooth Crème and the silicon mouth trays for



Figure 4: Panoramic and close-up views of the anterior teeth one month after the fluoride varnish treatment. Notice the presence of enamel lesions along the lower anteriors.



Figure 5: Appearance of the teeth fitted with a silicon-based mouth tray with a pea-sized amount of Tooth Crème applied to the upper and lower tray and positioned on the teeth. The patient was instructed to brush his teeth after dinner with the Clinpro® dentifrice, followed by placement of the tray for 15 minutes.

take-home use, and was instructed to perform the tray-based procedure before bedtime every night until the assigned toothpaste was exhausted.

Additionally, the patient was asked to cease smoking and return for a follow-up visit. Unfortunately, the patient could not maintain the scheduled appointment because he had plans to leave the country for the purpose of attending university.

The patient returned after 22 months for a prophylaxis and follow-up appointment. The patient had accumulated heavy plaque build-up on the teeth (Figure 6), and this was gently removed to reduce the potential for damage to possible underlying soft, chalky enamel. Afterwards, the teeth were dried with air and inspected for regions exhibiting demineralization. Noticeably, all mandibular anteriors previously manifesting white-spot lesions had remineralized, with light scar tissue being visible (Figure 7).

Discussion

The design of any preventive protocol must consider the patient's habits, drug use (over-the-counter, prescription and recreational, if possible), medical conditions or psychology, as these are some of the causative factors that can tilt the equilibrium (including the nature of the oral biofilms) of the mouth from a healthy to a pathogenic environment [3]. A 16 year old young man having dental caries on the labial surface of upper anteriors is somewhat unusual among the many patients seen and treated at our three Thaper Dental Clinics, and was considered to be at higher risk for dental caries. We comment that a favorable mindset is critical to a patient's outlook and compliance not only with their oral health but also to their overall health. The 16-year-old patient begrudgingly came to our clinic at the insistence of his mother. He had matured during the four year time period, allowing him to take full responsibility for his own dental health, without the insistence of his mother.



Figure 6: Appearance of the anterior teeth 22 months since the patient's last visit. The teeth manifested heavy plaque accumulations.



Figure 7: Close-up of anterior teeth on each side after gentle removal of plaque and air-drying the teeth. The previously hypomineralized regions on the lower anterior teeth have remineralized, the teeth are in stable condition and the gingival tissue appears healthy. Presence of scar tissue inherent to remineralization processes is visible on some of the teeth.

At the patient's first visit, it was necessary to immediately restore specific lesions in the mouth and this was performed with the fluoride-recharging and fluoride-releasing glass-ionomer in order to provide protection to the adjoining surface and the neighboring teeth. However, a number of tooth surfaces, especially the mandibular anteriors, exhibited significant decalcification, that were not yet too soft to break, posed concerns for lesion progression and aesthetic concerns. There are several clinical approaches to addressing these decalcifications. One approach may include limited surface etching followed by the application of either a sealant to the lesion surface or lesion-infiltration with resins [4]. Microabrasion techniques can be clinically effective in addressing hypocalcification [5]. But for clinicians opting for less invasive intervention without acid pre-treatments, topical applications of mineralizing therapies may be appealing. For example, fluoride varnishes are recommended as a clinically effective caries-inhibition measure, especially for children with developing dentition [6].

In this particular case, treatment with a fluoride varnish treatment failed to provide sufficient remineralization of hypomineralized enamel after a one-month period. The use of Clinpro® fluoride varnish was chosen based on its inclusion of functionalized tricalcium phosphate (fTCP) and its demonstrated clinical efficacy [7-9]. However, it became clear that application of a single fluoride varnish treatment to complement the patient's oral care regimen was not sufficient in remineralizing the lesions. This demonstrates the limitations of topical fluorides, including fluoride varnishes, in certain instances [2]. Additionally, poor remineralization may be related to the patient's habit of smoking, which has been shown to reduce saliva flow as well as increase the accumulation of periodontal pathogens [10,11].

Maintaining the perspective that minimally invasive interventions is key, a more intense level of therapy was devised that utilized tray-based

delivery of Clinpro® Tooth Crème, a low-abrasive dentifrice that contains sodium fluoride (950 ppm F-) and fTCP. The purpose of fTCP is to support fluoride-based remineralization and deliver functional forms of bioavailable calcium and phosphate that help incorporate fluoride deeper into enamel; in doing so, acid-resistant, enamel-like remineralization is achieved not only at the tooth surface but also within the subsurface lesions [7]. Although the dentifrice is formally designed to deliver fluoride, calcium and phosphate in a toothbrushing event, we have adapted its remineralizing capability by delivering these mineralizing ions via a tray-based application. The use of the custom mouth-tray extends the contact time of these minerals with the demineralized enamel, and subsequently works with the patient's saliva to generate improved remineralization as shown in Figure 7. The extended contact time allows fluoride to exert a response on both the enamel and the gingival tissue, thereby strengthening the enamel (in conjunction with calcium and phosphate) while limiting the activity of microbial pathogens. As salivary flow and clearance becomes minimal at nighttime, an environment rich in fluoride, calcium and phosphate accomplished via the tray-based treatment helps to prolong the dental benefits beyond the 15-minute application period.

When the demineralized regions remineralize with the aid of fluoride, less-soluble mineral layers are formed, resulting in improved stability against acid attacks. This helped to explain the observation that when the patient returned after 22 months he was without caries. Furthermore, the demineralized regions had sufficiently healed, with the natural formation of scar tissue that developed during the remineralization process. Such scar tissue is a component of the healthy tooth structure and has only cosmetic importance for some patients.

We note the success of this technique is dependent upon the patient's compliance. Importantly, instead of using a multi-step treatment plan, the dentifrice comprising both fluoride and fTCP in this single-step procedure was critical to maintaining an easy-to-use regimen for the patient. It appears the patient's use of the dentifrice-tray combination for six months achieved the desired remineralization; subsequent use of standard toothpaste was sufficient to maintain the achieved remineralization of the hypomineralized lesions. Also, this technique may find application in reducing dental hypersensitivity from localized exposed root surfaces, or from generalized post-bleaching tooth sensitivity. Finally, the technique can also be used to improve gingival health.

Clinicians utilizing preventive approaches to manage reversible oral health conditions must be confident that prevention therapy is effective and that remineralization can be achieved. A major key to implementing a preventive-based approach is the customized treatment protocol for the need of the patient: the higher the decay-risk, the more aggressive and/or creative prevention-focused protocol might be required. As always, the patient's desire to care for his/her own oral health and maintain compliance to a recommended regimen is critical to the success of a treatment plan. As clinicians, we need to remain open to increasing or decreasing the level of prevention as per the patient's progress. Through judicious and intelligent adaptation of the tools available to both the clinicians and the patients, we can effectively address reversible oral health conditions that might otherwise develop into future decay problems (e.g. secondary caries).

Conclusion

Instead of utilizing procedures that may result in tissue loss (no matter how minimal), reversible conditions in moderate-to-high-risk patients can be addressed via creative approaches, such as delivery of a multi-mineral dentifrice via mouth trays. The simplicity of a dentifrice comprising fluoride, calcium and phosphate helps to enable a creative, straightforward and effective remineralization protocol for a moderate-to-high-risk patient with initial caries lesions.

Clinical Relevance

Minimally invasive approaches for reversible oral health conditions can be successful but require a commitment from the patient and clinician. Even though such approaches likely involve patience and creativity, the successful remineralization of initial caries lesions of this patient is an example of the importance of understanding the psychology of the patient, acquiring a detailed history of habits, and devising custom, preventive-focused protocols to fit the patient.

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